Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

A280.39
M34Am
cop.4

LIBRARY
CURRENT SERIAL RECORD
★ AUG 12 1959 ★
U. S. DEPARTMENT OF AGRICULTURE

AMS-331

Economies of Scale in
CHICKEN PROCESSING

U. S. Department of Agriculture
Agricultural Marketing Service
Marketing Research Division
in cooperation with
New Hampshire Agricultural Experiment Station and Massachusetts Agricultural Experiment Station

PREFACE

Poultry processing is a mass-volume business of relatively recent origin. The development of modern processing technology and machinery has had tremendous impacts on the poultry industry. The number of firms processing poultry has declined and the average size of processing plants has increased. Costs have dropped sharply despite substantial increases in wage rates and in prices of other items used in processing operations.

Questions have been raised concerning the nature of the costs and economies of scale in processing poultry and of the adjustments that poultry processing plants must make to survive and prosper. Such questions acquire considerable importance and urgency in an industry in which continued progress toward higher operating efficiency is a major weapon of competition.

This report presents some of the highlights of a study undertaken to aid plant managers to increase operating efficiency within plants and to make other adjustments in policies and practices which will contribute to maximizing the efficiency of the firm. The study is a part of a broader research program conducted cooperatively by the Agricultural Marketing Service and the New Hampshire and the Massachusetts Agricultural Experiment Stations to improve the marketing of poultry and eggs.

The complete report providing much more detailed information has been issued as Bulletin 459, "Marketing New England Poultry. 2 - Economies of Scale in Chicken Processing," by the Agricultural Experiment Station, University of New Hampshire, Durham, N. H.

CONTENTS

	Pages
Introduction	3
Characteristics of plant costs and investment	4
Scale effects in processing broilers	5
Scale effects in processing fowl	5
Implications for the individual firm	8
Effects on industry structure and costs	9
Conclusions	9
Selected references	11

August 1959

ECONOMIES OF SCALE IN CHICKEN PROCESSING

By George B. Rogers and
Edwin T. Bardwell [1]

Introduction

Development of new technology in poultry processing, a widening mass-market demand for chicken, and other changes in the industry have focused attention on increasing processing efficiency through expanding volume and plant size. Earlier studies differ with respect to (1) the rate of decline in average costs per pound with increasing scale of operations, and (2) the maximum feasible plant size. Clearly, therefore, a thorough analysis of costs and economies of scale in chicken processing was needed.

This study includes model processing plants ranging in capacity from 150 to 10,000 broilers (3.5 pounds live weight) an hour. The capabilities of the same plants in processing 6-pound fowl (live weight) also are examined. Plants with a capacity of 150 birds an hour and above usually sell to wholesale and jobbing outlets. Smaller plants generally engage in direct-to-consumer and retailer selling. The plant with a capacity of 10,000 broilers per hour is larger than any unit presently operating in New England.

This "economies of scale" study is not a report on actual average operating costs of a sample of plants of different sizes. The analysis involves a synthesis of efficient model plants of different capacities and the standardization of levels of operation as well as of facilities, equipment, practices, market classes and weights, and prices of inputs. Cost records of 15 actual plants and data from equipment manufacturers and other sources helped determine organizational features, input-output relationships, and cost rates.

While the study on which this report is based deals with New England processing plants, their technology and operating practices are comparable to those in most other areas. Thus, cost relationships determined among plants of different sizes should have general applicability. Inefficiencies in the present processing system in New England result from both the practices of individual firms and the structural features of the industry. Other areas have similar problems. Therefore, the large potential savings available within New England, as shown in this study, may also be possible for the industry in other areas.

---

[1] Mr. Rogers is an agricultural economist, Market Organization and Costs Branch, Marketing Research Division, Agricultural Marketing Service. Mr. Bardwell is a cooperative agent of AMS and the New Hampshire and the Massachusetts Agricultural Experiment Stations.

The nature, extent, and timing of adjustments which an individual firm makes to attain economies of scale in processing will be affected by its location, short-run technological advantages, and costs and economies of scale in assembling live birds and distributing poultry meat. Smaller plants may prove most economical in some noncommercial poultry areas or in situations where the operating margin of the firm can be widened by advantageous buying and selling prices and practices. In the short run, use of depreciated and low-cost resources and substandard practices may offset some of the inherent economies of scale in processing. But over a longer period resources will have to be replaced and practices improved and standardized. This is likely to result in a continuing reduction in plant numbers, particularly those of smaller size, and in greater attention to the effects of size on costs. Further progress toward enhanced efficiency and lower costs will increasingly depend upon the ability of management to realize fractional unit cost savings which translate to large dollar savings on large volumes.

Characteristics of Plant Costs and Investment

Capital investment required for poultry processing plants is substantial, ranging from more than $20,000 for the model plant with a capacity of 150 broilers an hour to almost $700,000 for the 10,000 size. As plant size increases, investment in equipment climbs much more rapidly than investment in buildings and related items, but total investment increases less than proportionately with size. That is, as plant capacity increases, investment per unit of capacity declines.

Wages and salaries are the principal cost of poultry processing. These are followed by supplies and materials. Over the range of sizes of broiler plants studied, costs per pound for wages declined 59 percent, salaries (management) 67 percent, capital costs 36 percent, and all other costs 15 percent. 2/

Costs can be classified under four types: Variable operating, constant-unit operating, fixed operating, and fixed overhead. Major components of variable operating costs are plant wages, variable repairs, wear depreciation, electricity, and water. Wage costs per pound decline as plant volume increases up to 100 percent of capacity but increase thereafter, causing an upturn in the average cost curve for each plant, as shown in figure 1. As volume rises, costs per unit of output increase for variable repairs but decline for wear depreciation. Utilities have a fixed initial charge and successively lower rates with increases in physical units used.

Constant-unit operating costs cover items used in direct proportion to volume. Major items are packages, ice, and expendable supplies.

2/ All costs per pound in this report are on the basis of live weight. They can be converted to an eviscerated weight basis by dividing by the percentage yield from live to eviscerated weight. A typical yield figure is 0.73 for broilers.

When a plant begins operation, it sustains costs for management and certain other items essentially fixed in total. These fixed operating costs per unit of output decline in direct relation to any increase in volume.

Fixed overhead costs relate to ownership of plant and equipment. Average costs per pound decline in direct proportion to an increase in volume. Included are certain elements of depreciation and obsolescence on equipment, all depreciation on buildings and facilities, property taxes, interest, insurance, plant repairs and maintenance, and equipment maintenance.

Scale Effects in Processing Broilers

For the 10 model plants designed to process 150 to 10,000 broilers an hour, savings in costs from the smallest to the largest plant are 2.5 cents a pound (table 1) when each is operated at full capacity. More than half of this advantage is obtained with volumes between 150 and 600 broilers an hour. More than three-fourths is reached at the 2,400-an-hour size. From the 2,400 to 10,000 sizes, the additional savings are only about 0.5 cent a pound.

Although the decline in average costs between successively larger plants becomes smaller as plant size increases (figure 1), total savings are large and continue to increase. For this reason the small differences shown in this report in costs per unit of output have important implications for individual firms and to the marketing system. For example, in a plant with a capacity of 10,000 birds an hour processing 69.2 million pounds of broilers annually, the cost would be $1,828,000 at 2.6 cents a pound. The same volume processed in two plants with capacities of 5,000 broilers per hour, at 2.9 cents a pound, would cost $1,978,000, or $150,000 more.

Scale Effects in Processing Fowl

Average processing costs per pound for fowl in all model plants are lower than for broilers (table 1). The smaller number of birds per hour is more than offset by the greater weight per bird. The economies of scale for fowl in figure 2 are not as pronounced as those for broilers, nor is the curve as smooth. Some irregularity occurs in the economies of scale curve for fowl. This suggests it may be a matter of indifference which type of available technology is used at certain output levels.

Economies of scale accruing to successively larger plants are considerably less with fowl than with broilers. The cost difference from the smallest plant (120 fowl an hour) to the largest plant (6,000) is only 1.4 cents a pound. Almost 85 percent of this saving occurs between plants processing 120 and 480 fowl an hour. Between the 480 and 6,000 sizes, costs decline only 0.3 cent per pound. This difference is substantially less than the 1.2 cents a pound savings resulting between the comparable plants processing broilers. But the total dollar savings in processing a given quantity of fowl through a single larger plant rather than two or more smaller plants would still be substantial.

Table 1.--Processing costs per pound for broilers and fowls in 10 different-sized plants running at 100 percent of capacity 1/

Type of bird and kind of cost	Size of plants by number of birds processed per hour									
	150	300	600	1,200	1,800	2,400	3,600	5,000	7,500	10,000
3.5-pound broilers	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
Variable operating costs	3.117	2.573	2.261	2.044	1.857	1.748	1.612	1.545	1.458	1.386
Constant-unit operating costs	0.880	0.880	0.860	0.840	0.820	0.820	0.800	0.800	0.800	0.800
Fixed operating costs	0.868	0.545	0.462	0.483	0.433	0.430	0.396	0.369	0.345	0.324
Fixed overhead costs	0.265	0.217	0.220	0.219	0.186	0.181	0.161	0.145	0.139	0.132
Total	5.130	4.215	3.803	3.586	3.296	3.179	2.969	2.859	2.742	2.642
	120	240	480	900	1,260	1,600	2,300	3,000	4,500	6,000
6-pound fowl	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
Variable operating costs	2.272	1.878	1.570	1.593	1.549	1.534	1.472	1.427	1.420	1.349
Constant-unit operating costs	0.860	0.860	0.840	0.820	0.800	0.800	0.780	0.780	0.780	0.780
Fixed operating costs	0.633	0.397	0.322	0.376	0.361	0.377	0.362	0.359	0.336	0.315
Fixed overhead costs	0.194	0.155	0.154	0.171	0.156	0.158	0.157	0.139	0.135	0.129
Total	3.959	3.290	2.886	2.960	2.866	2.869	2.771	2.705	2.671	2.573

1/ 1957 data. Live weight basis costs; may be converted to eviscerated weight basis costs by dividing by 0.73, a typical yield figure.

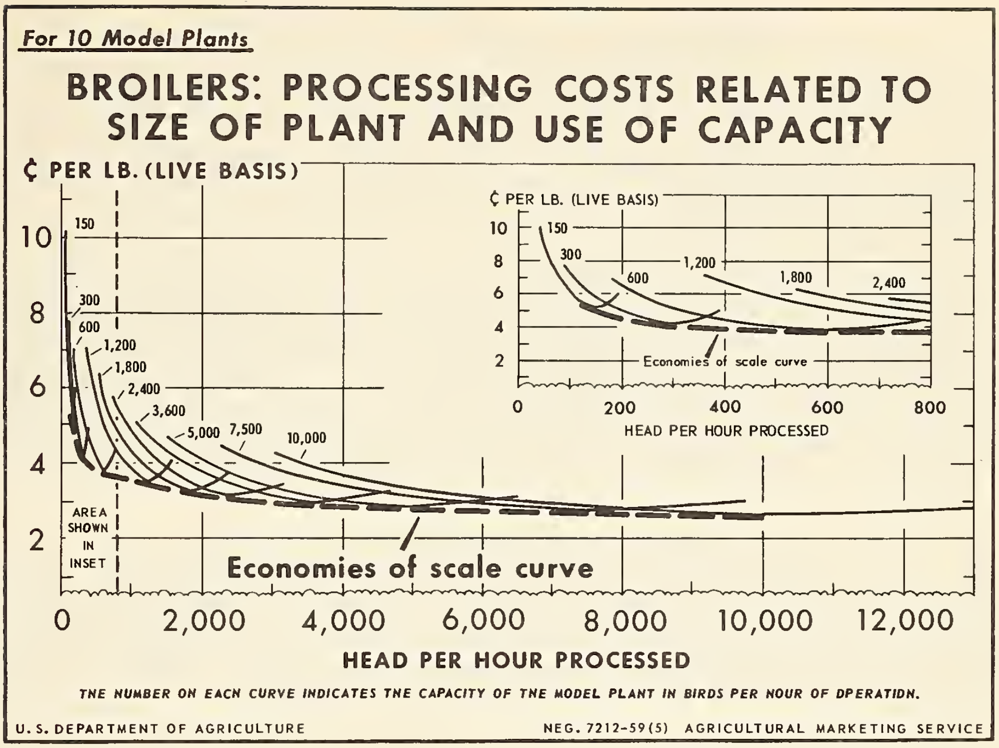

Figure 1

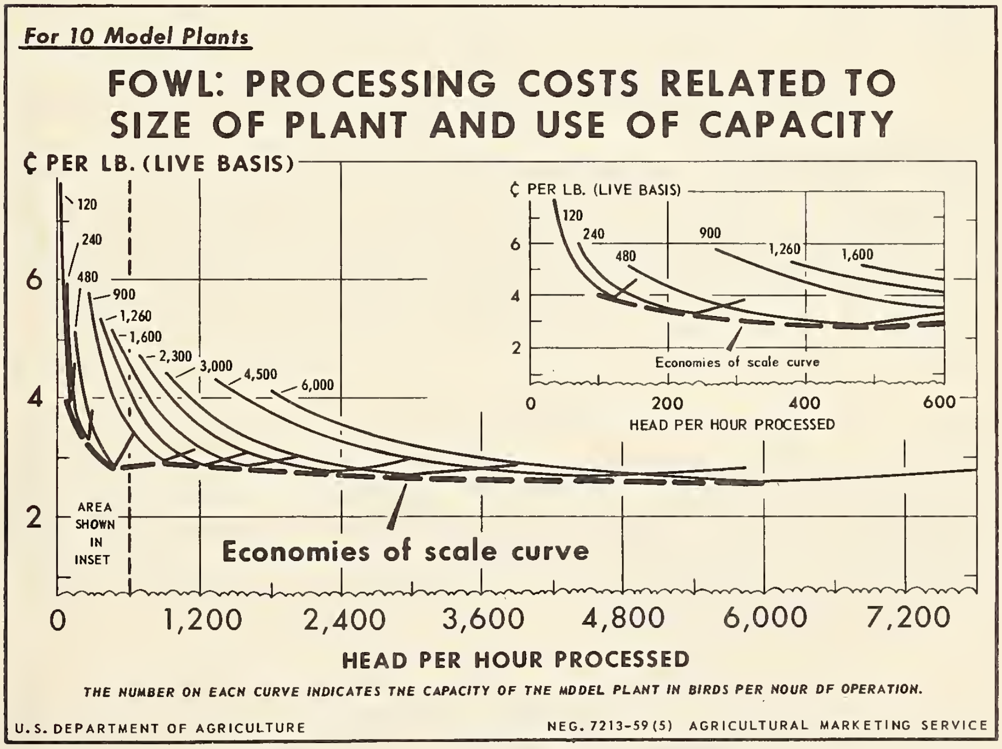

Figure 2

Implications for the Individual Firm

Of prime importance to the individual plant manager are those parts of his operation in which he can make decisions relating to costs and efficiency. These include: Substitution of capital for labor, organization of the working force, plant size, utilization of plant capacity, and the emphasis on particular market classes.

All costs do not contribute equally to the economies associated with increases in scale. In table 1 this is indicated by the different rates by which the several classes of costs decline as scale of operations increases. Those that decline the most are wage, salary, and capital costs. These costs account for 78 percent of the costs per unit of output of a broiler plant of 150 birds an hour capacity and 63 percent for a plant processing 10,000 broilers per hour. Fortunately, these costs can be minimized by proper managerial decisions.

On the other hand, management has little decision-making power with respect to some cost items. Prices of many items used in processing are determined by forces external to the poultry industry. Rates of use of supplies, materials, utilities, and miscellaneous items are related to trade practices, sanitary standards, and machine capacities.

For any particular model plant size, average costs per pound are lowest at 100 percent of capacity. Hence, plant operators should seek a level of operations as near full capacity as practicable. Furthermore, expansion of plant size should be considered, as economies of scale, or declining costs per unit of output, were realized even in the largest plant size included in this study. Achievement of these objectives will become increasingly related to participation in contract growing programs to supplement supplies the plant is able to obtain through maintaining "good will" with independent producers.

Increasing plant size permits greater specialization within the labor force. Hence, waste time is reduced and a greater proportion of workers is employed at near-peak efficiency. Levels of labor efficiency attainable in model plants exceed those observed in actual plants. This occurs because labor efficiency in actual plants is curtailed by sporadic variations in volume, changes in plant size, and in forms in which product is sold, and problems associated with labor turnover and the training of new employees.

Substantial economies in managerial and supervisory functions also are possible in large-scale operations. These deserve more attention than they have been given in most plants. Moreover, the quality of personnel at the managerial and supervisory levels will be reflected in the levels of efficiency of operating departments. Large-scale plants will find it worthwhile to pay high salaries for specialists in these functions who can enhance the efficiency of the whole operation.

The size of the processing plant also influences its competitive position regarding the processing of various market classes of birds. Large plants can obtain greater cost advantages over smaller plants in processing broilers than they can in processing fowl. While the large plant can use fowl to help stabilize volume, it would be to the plant's advantage to assure itself of a more adequate broiler supply. Since broilers are adapted to year-round production, a supply can be created through contract growing programs.

In contrast, fowl is a byproduct of the farm egg enterprise, and supplies are seasonal. Prospects for obtaining a steady supply for processing decline with increasing plant size and lower density of flocks. Whereas larger plants may experience difficulties in procuring adequate supplies of fowl, the small plant readily may do so. Furthermore, fowl and other heavier birds provide the best competitive adjustment for small plants. Their costs for fowl per unit of output are not so high relative to the large plant as for broilers. With large plants unlikely to be able to secure adequate supplies of fowl, discussions of economies of scale in processing fowl should, as a practical matter, be limited to plants with capacities of less than 3,000 head per hour.

Effects on Industry Structure and Costs

In addition to the savings which plants can achieve through improved efficiency and economies of scale, substantial savings can result from structural changes in the industry. The New England region may be used as an example.

About 240 New England slaughtering and eviscerating plants and a number of additional establishments eviscerating prior to the retail level processed 427 million pounds of poultry in 1957 at an estimated cost of $17.7 million. If all evisceration had been done in the 240 plants, and if these plants had operated at levels of efficiency comparable to the model plants described in this report, processing costs could have been reduced to $16.1 million.

Furthermore, one-fourth as many plants, but of larger size and with capacity operations at model levels of efficiency, could have processed the same volume for $14.1 million. In future years, economic forces will cause reductions in plant numbers and increases in plant size. If output were to expand 40 percent, one-fourth as many plants as exist today, but of larger average size, could process the larger volume with only a 10-percent increase in total dollar costs above 1957 actual levels.

Conclusions

The development of poultry processing as a mass-volume business is still of fairly recent origin. Management has probably not fully assumed its full role in increasing efficiency in most plants. The lack of consistently good and uniform records kept by plants and the frequent dearth of essential information on which they can base decisions suggest that "playing by ear" is still commonplace. As additional facts are made available through research, management can systematically improve the efficiency of the firm.

In the current study, single shift operations were assumed for all model plants. Further economies might be achieved by the introduction of a second and possibly a third shift provided certain related problems can be solved.

Additional efficiencies in plant operations may be achieved with new technology and new machinery, some of which is being developed by equipment-manufacturing firms. The principal operations which seem to warrant further research attention are receiving, cooling, packing, cutting-up, and freezing.

The benefits to poultry firms from economies of scale under present and future technology are likely to have increasing effects on the poultry industry, in terms of the number and size of poultry processing plants, resources and inputs per unit of output required in processing, methods of assembly and distribution, and economic integration. Research is now under way in these areas under cooperative arrangements involving the Agricultural Marketing Service of the U. S. Department of Agriculture and the New Hampshire and Massachusetts Agricultural Experiment Stations.

SELECTED REFERENCES

Abbott, J. C.
1954. The Economic Implications of Recent Technical Developments in the Processing of Turkeys. Calif. Agr. Expt. Sta. (Giannini) Mimeo. Rpt. 172.

Baum, E. L., Faris, J. E., and Walkup, H. G.
1952. Economies of Scale in the Operation of Fryer Processing Plants. Wash. Agr. Expt. Sta. Tech. Bul. 7.

Bressler, R. G., Jr.
1942. Economies of Scale in the Operation of Country Milk Plants. New Eng. Res. Council, New Eng. Agr. Expt. Stas. and U. S. Dept. Agr. cooperating.

Donald, J. R., and Bishop, C. E.
1957. Broiler Processing Costs - A Study of Economies of Scale in the Processing of Broilers. N. C. State Col. Dept. Agr. Econ. A. E. Inf. Ser. 59.

Farrish, R. O. P.
1959. Factors Affecting the Output, Size, Costs and Location of Poultry Plants in Southern New England. Conn. Agr. Expt. Sta. and U. S. Agr. Mktg. Serv. cooperating. (In press.)

Gerald, J. O., and Kahle, H. S.
1955. Marketing Georgia Broilers Through Commercial Processing Plants. U. S. Dept. Agr. Mkt. Res. Rpt. 83, Ga. Expt. Sta. cooperating.

Hackamack, L. C.
1956. Managerial Efficiency in Dairy Processing Plants. Univ. of Mass. Agr. Expt. Sta. contrib. under Hatch Project No. 134.

Henry, W. F., Bressler, R. G., Jr., and Frick, G. E.
1948. Efficiency of Milk Marketing in Connecticut. II--Economies of Scale in Specialized Pasteurizing and Bottling Plants. Storrs (Conn.) Agr. Expt. Sta. Bul. 259.

Rogers, G. B., and Bardwell, E. T.
1959. Marketing New England Poultry. 2--Economies of Scale in Chicken Processing. N. H. Sta. Bul. 459. N. H. and Mass. Agr. Expt. Stas. and U. S. Agr. Mktg. Serv. cooperating.

______________ Henry, W. F., Brown, A. A., and Bardwell, E. T.
1957. Marketing New England Poultry. 1--Characteristics of the Processing Industry. N. H. Sta. Bul. 444. N. H. and Mass. Agr. Expt. Stas. and U. S. Agr. Mktg. Serv. cooperating.

______________ Henry, W. F., Brown, A. A., Bardwell, E. T., and Deoss, D. L.
1958. Economies of Scale and Current Costs in New York Dressing Broilers and Fowl. N. H. Agr. Econ. Res. Mimeo. 20. N. H. and Mass. Agr. Expt. Stas. and U. S. Agr. Mktg. Serv. cooperating.